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TESTING NEW FEATURES OF WINDOWS SERVER 2012 R2

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Microsoft introduced the newest version of the Windows server, Windows Server 2012 R2, along with numerous features and enhancements. According to Microsoft, these features make the software easier for both server administrators and users; and many of these new features were not possible in the earlier version of the Windows Servers because of the limitations within their own functionality.

The aim of this thesis is to test new features of Windows Server 2012 R2 in a Microsoft-recommended environment. Of these, it mainly focused on three features, namely, Work Folders, Hyper-V and Generation 2 Virtual Machines.

The installation and configuration of the software in both servers and client devices were carried out with Graphical User Interface (GUI) mainly and the features were tested through different software tests such as functional, performance and usability tests. The tests showed that there were consistency between the Microsoft claims and the test results.

The new features of Windows Server 2012 R2 makes day-to-day server handling more efficient and productive by aiding in swift collaboration.

KEYWORDS:

Windows Server 2012 R2, Hyper-V, Work Folders, Virtual Machines.

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LIST OF ABBREVIATIONS (OR) SYMBOLS

ADDS	Active Directory Domain Services
AVMA	Automatic Virtual Machine Activation
BIOS	Basic Input/Output System
BYOD	Bring Your Own Device
DEP	Data Execution Prevention
GUI	Graphical User Interface
Hyper-V	Hyper Visor
IDE	Integrated Development Environment
NTFS	New Technology Files System
PXE	Preboot Execution Environment
QoS	Quality of Service
SCSI	Small Computer System Interface
SSO	Single-Sign-On
UEFI	Unified Extensible Firmware Interface
VHDX	Virtual Hard Disk
VPN	Virtual Private Network
VM	Virtual Machine
WS2012 R2	Windows Server 2012 R2

1 INTRODUCTION

Windows Server is a group of operating systems designed by Microsoft that supports enterprise-level management, data storage, applications, and communications. Previous versions of Windows Server have focused on stability, security, networking, and various improvements to the file system. Other improvements have also included improvements to deployment technologies, as well as increased hardware support (Microsoft MSDN, 2015). Unlike, the UNIX-based operating system, the Windows server offers ease management through its user interface. It also supports most of the web technologies such as PHP, MySQL, ASP.NET.

Microsoft has introduced both general and special versions of servers. Although Microsoft introduced its first Windows operating system in November 1985, the server version was released only in April 2003, which was Windows Server 2003. Thenafter, Windows Server 2003 R2 (December 2005), Windows Server 2008 (February 2008), Windows Server 2008 R2 (July 2009), Windows Server 2012 (August 2012) and Windows Server 2012 R2 (October 2013) were released in chronological order.

Windows Essential Business Server (September 2008), Windows Small Business Server (2003, 2008 and 2011), Windows Home Server and Windows Home Server 2011 are Stock Keeping Unit (SKU) versions of the Windows server while rest are general versions.

The aim of the thesis is to test new features of Windows Server 2012 R2 (WS2012 R2) in a Microsoft-recommended environment. Furthermore, it will be focused on Work Folders, server virtualization wtih Hyper-V (Hyper Visor) products and generation 2 Virtual Machine (VM). Moreover, it will explore some key factors within those features. After reading this, readers gain knowledge about WS2012 R2 and its significance, along with some new features. Thus, the readers will be able to select and install the features that will be best suited for their needs.

The thesis starts with an introduction of Windows Server and its significance in Chapter 1. Chapter 2 comprises a description of Windows Server 2012 R2 and its new features and Wok Folders, Hyper-V and generation 2 VM features in detail, whose testing will be carried out later. Requirements of testing environment and testing aspects are explained in Chapter 3. Chapter 4, presents the tested features and results. The conclusion of the features' testing and their possible future works are in Chapter 5.

2 WINDOWS SERVER 2012 R2

Windows Server 2012 R2 is the newest version and sixth release of Windows Server. It was announced at TechEd North America 2013 in June 3, 2013 and released in October 18, 2013 by Microsoft (Caro, 2013). It is a successor of Windows Server 2012. In addition, WS2012 R2 update, also know as Service Pack, was released in April 8, 2014 and it mentioned that the same update also works for Windows 8.1 (Microsoft Blog, 2014). This version of Windows server requires an x64 bit processor and can be installed in Itanium based computers having Intel Itanium 2 processor and additional hard disk space, unlike its predecessor.

The minimum and Microsoft recommended hardware requirements for installing WS2012 R2 is shown in Table 1. (Poulton and Camardella, 2015, p.40)

Table 1. Minimum requirements for WS2012 R2

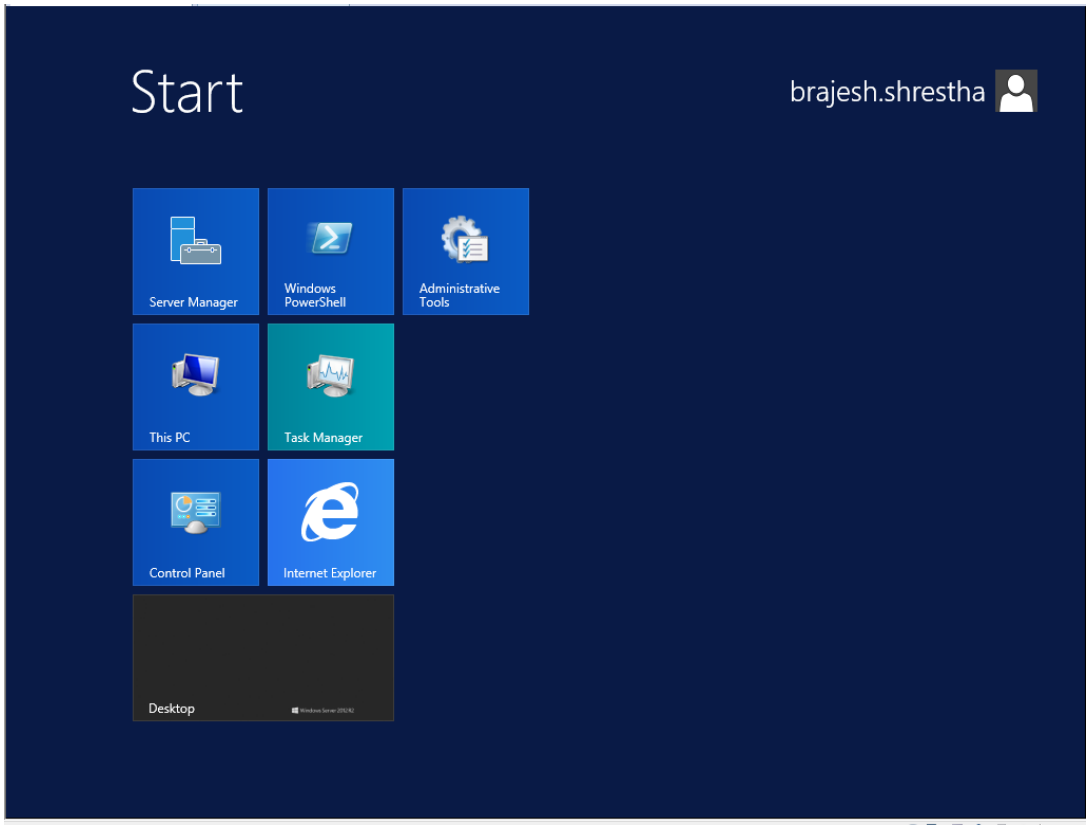
Component	**Minimum Requirement**	**Microsoft Recommended**
Processor	1.4 GHz 64 bit	2 GHz or faster
Memory	512 MB RAM	2 GB RAM or greater
Available Disk Space	32 GB	40 GB or greater
Optical Drive	DVD-ROM drive	DVD-ROM drive
Display	Super VGA (800x600) monitor	XGA (1024x768) monitor

The WS2012 R2 product has four editions.

- The Datacenter edition (for highly-virtualized private clouds)
- The Standard edition (for non-virtualized or lightly virtualized environments)
- The Essentials edition (for small businesses with up to 25 users running on servers with up to two processors)
- The Foundation edition (for small businesses with up to 15 users running on a single processor servers)

The features of the Datacenter and the Standard editions are identical, the only diffrerence is their way of licensing in virtual instances. Similarly, the Essentials edition has same features as the Datacenter and the Standard editions have, except for some restrictions. Of these, the Essentials version automatically backs up client computers to the server and can help to restore easily the entire computer or individual files and folders from its backup (Microsoft, 2015).

Microsoft has greatly improved the old features and introduced over 300 features and enhancements in WS2012 R2. These features brought a lot of new capabilities to the infrastructure of almost all areas of WS2012 R2, such as in File Services, Storage, Networking, Clustering, Hyper-V, PowerShell, Windows Deployment Services, Directory Services and Security areas. In addition, it is the first server version of Microsoft which has a connection with the cloud (Minasi et al. 2014). A screenshot of startup screen of WS2012 R2 Datacenter Edition is shown in Picture 1.



Picture 1. Startup screen of WS2012 R2 Datacenter Edition

The storage function of the server comes with a new feature called storage tiering. It actually dynamically moves chunks of stored data between different classes of storages, such as fast solid state drive (SSD) and slow hard disk drive (HDD). In this case, the heat map algorithm is used to determine, which chunks of data needs to be on fastest tier and which on the slowest.

Next, another new feature, the multi-tenant Virtual Private Network (VPN) gateway allows site-to-site VPN gateway. It creates a single VPN link to connect multiple external sites. This facilty helps an organization to work with only few number of VPNs, which makes it easy to implement and lower the investment cost (Feril, 2013).

Similarly, Hyper-V has a number of new features and capabilities, which makes it really a powerful tool for virtualization world of server (Tulloch, 2013). It can replicate VM between systems, clusters and data centers in order to revcover data from any kind of disaster. In addition, it also offes variable replication frequency options with the fastest (30 sec) and the slowest (15 min) rates. There is also te possibility of storage migration even when VM is running. Similarly, there is a new facility to revocer deleted storage space in a live VM with the help of a virtual snapshot (Minasi et al. 2014). Last but not least, it can back up the Windows server to Linux guests.

Among new features and enhancements, the thesis will be focused on only three new features, namely Work Folders, Hyper-V and Generation 2 VM, in detail.

2.1 Online Storages with Work Folders

Work Folders (also referred as Workplace Folders) is one of the most interesting features of WS2012 R2 and it was introduced by Microsoft in order to work easily on work files. It is one of the File and Storage Service features that enables users to store and access their work files with their personal devices (PC, Laptop, tablet and Smartphone). Users will have a particular

location in centrally managed file servers on a corporate network, which can be accessed from anywhere (both outside and inside of the corporate network). In addition, it enables administrators to control organizational data and users devices' policies such as encryption and lock-screen passwords (Microsoft Technical Library, 2013, p.3599).

Work Folders can be implemented on any number of file servers within a customer environment. In addition, it helps an organization to adopt "Bring Your Own Devices (BYOD)" policy.

The growing number of personal devices (smartphones, tablets, laptops, PC) and information they can access is changing peoples' lifestyle. In addition, the easy access of information on those devices, whenever they want, demarcates the traditional border between home and work life. It facilitates extension of users' activities and schedules into workplace too and they can work for office whenever they want. However, for this, the users' personal devices should be connected with corporate servers in order to synchronize their office works.

It is true that, there are already some applications (for example, SkyDrive, Google drive, Dropbox, iCloud and other online storages) which help to access work files from out of office, are compatible with almost all type of devices and synchronize files and folders. However, these applications mostly come with problems. The primary one is their design. They are mainly designed for personal purposes and if some are for business, they are usually expensive. In addition, storing data in those online storages poses security risks. Nevertheless, company administrators cannot modify the settings of these applications in the user's devices which might be unfriendly to corporate companies.

Another problem is the place to store. Storing data only on hard drives of personal devices is not a good idea as hard drives can fail at any time and the data could be lost. Similarly, the storing capacity of some personal devices such as tablets, might not be adwquate and if they are adequate, there is always a risk of data leakage when devices are lost or stolen.

Last but not least, data is online only when devices are joined to the company's Active Directory Domain Services (ADDS) in the previous versions of Windows server. The offline data is stored in the hard disk of the device. So, there is a chance user would work on outdated (unsynchronized) data, if the user has been offline for a long time (Dizdarevic, 2013).

To eliminate these limitations, Microsoft has introduced a new feature, Work Folders, in their newest version of Windows Server, i.e., WS2012 R2. It helps users to access latest work data from their personal devices, regardless of users' internal or external location. It also removes the obligation of using VPN, DirectAccess (DA) or any kind of remote access connection as the user does not need these tools to access corporate server. Furthermore, administrators can also be granted permission to modify this technology's setting such as user device policies and manage user data.

2.2 Server virtualization with Hyper-V products

Microsoft Hyper-V is a server virtualization product, codenamed "Viridian", developed by Microsoft Corporation. It is Microsoft's next generation hypervisor-based server virtualization technology, following its earlier Virtual Server product. Microsoft releases new Hyper-V versions with new Windows server versions. Thus, till now, there are four versions, including Windows Server 2012 R2, Windows Server 2012, Windows Server 2008 R2 and Windows Server 2008.

Hyper-V is a Windows Server feature and is installed whenever a server administrator decides to do so. Beside this, it is also available as a separate product called Microsoft Hyper-V Server. It is installed through Windows Wizard of adding roles, from OS. But, after installation, it redesigns the OS architecture and becomes just like a next layer on the physical hardware as decribed by Andrew Zhelezko in Figure 1. Such a created layer i.e. virtualized layer is used to install other operating systems. Thus, it enables to create and manage all

VMs and their resources. Within one physical computer, each VM acts as an isolated, virtualized computer system that can run its own OS. The OS that runs within a VM is called a guest operating system (Microsoft Library, 2015).

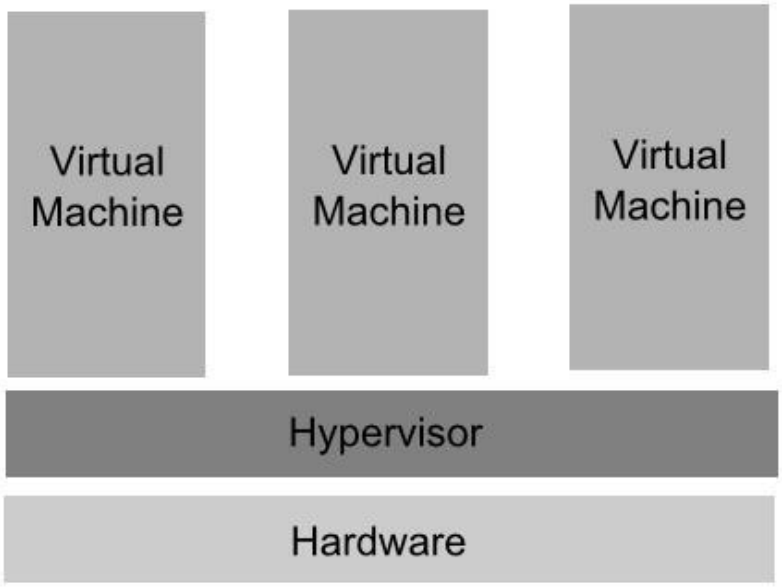


Figure 1. Position of Hyper-V architecture in OS (Zhelezko, 2014)

Hyper-V provides software infrastructure and basic management tools (through an integrated management console) that can be used to create and manage a virtualized server computing environment. This virtualized environment can be used to address a variety of business goals aimed at improving efficiency and reducing capital costs (Microsoft Library, 2010). Creating an environment for running multiple OS at the same time on one physical computer is one of the best ways for reducing cost. It also provides the complete end-to-end functionality for an enterprise-grade virtualization product. It also represents the foundation of Microsoft's vision for the cloud operating system (Tulloch, 2013).

Although Hyper-V Manager as a virtualization platform already existed in the Windows Server 2008 version, great improvement in the older features along with many new features has been introduced in WS2012 R2.

The operating systems and hardware systems are becoming powerful since their invention. Further, in their early invention, organizations tried to run more and more applications on a single host. However, this results in conflicts into applications because of their limitations in the running environments. Even today's latest architecture cannot use its full capacity on a single application. According to Microsoft Library (2013), only under 5 – 15% capacity will be used by majority of architecture and this is obviously a waste of a lot of potential. Nevertheless, purchasing physical hosts, energy to power and cool these hosts rises the investment of any organization.

Thus, organizations had to search for ways in order to lower investment cost and maximize the use their physical server. For this, Hyper-V became one of the best solutions as it can create a virtual environment where different VMs can run side by side. The VM alone can act as a physical host alone and almost all applications can run without any interruption. Furthermore, the Hyper-V of a single physical host can setup more than 25 VM (25:1) normally, which will be sufficient for small to medium sized organizations.

For large sized organizations, it would be easy and cheap to provide virtualized platform for workloads, than using any physical hosts. Therefore, Hyper-V is a perfect complement for virtualization and can handle all virtualization workloads without any problem (Cerling and Butler, 2010, p-5).

Since the debut of Hyper-V, several features had been improved and added to it. These improvements make it more stable and easy in the world of virtualization. Some of key features are as follows:

- New architecture
  The 64-bit native hypervisor-based virtualization provides a new array of device support as well as performance and security improvements.

- Multi-bit operating system support
  It can run both 32-bit and 64-bit operating systems simultaneously. In addition, it also supports UNIX operating systems.

- Support for symmetric multiprocessors

  It makes VM faster by supporting up to 64 processors in VM environment.

- Network load balancing (NLB)

  Balancing network load is another key feature of Hyper-V as name suggests. It balances the network load across VMs on different servers by supporting Jumbo Frames and Virtual Machine Queue (VMq).

- New hardware architecture

  Its new architecture provides improved utilization of resources such as networking and hard disks.

- Quick migration

  The feature allows to run VM in clustered environment with switchover capabilities when there is a failure. Ultimately, it reduces downtime and achieves higher availability of VM.

- Virtual machine snapshot

  Snapshot of running VM makes it easier to recover any previous virtual machine’s snapshot as the snapshot captures the state, data, and hardware configuration of a running VM.

- Resource metering

  It provides an ability to track and report the amount of data that is transferred per IP address or VM in order to determine accurate chargebacks.

- Scripting

  Scripting through Windows Management Instrumentation (WMI) interfaces and Applicatin Programme Interface (API) is possible and used to automate certain processes in selected VM.

- Network isolation

  Hyper-V in-built network virtualization isolates virtual networks from the physical network infrastructure of host. Furthermore, it removes the obligation of assigning IP addresses or other VLAN (Virtual Local Area Network) isolation processes.

- Dynamic memory

  It adjusts the amount of memory available to the VMs in response to the need of VMs. The feature balance memory among all running VMs and maintains consistent workload performance and scalability. The feature is especially excellent in a scenario where the amount of memory needed by VM changes over time, for instance, Web servers in Linux.

- Data Center Bridging (DCB)

  It helps to reduce the cost and difficulty to maintain separate network, management, live migration and storage traffic by using a modern converged 10-gigabit local area network (LAN).

2.3 Generation 2 Virtual Machines

One of the important features of WS2012 R2 in its Hyper-V virtualization is its support of new generation of VM, referred as Generation 2 VM, along with older generation 1 VM. It does not require any emulated drivers, unlike in generation 1 VM. In addition, it can run along with Generation1 VMs.

Each generation 2 VM can support more than four DVD drives and up to four Small Computer System Interface (SCSI) controllers, with each controller supporting 64 devices. Therefore, it can support 256 storage devices in total. However, it does not support any virtual floppy disk (.VFD) (Microsoft Library, 2013). It takes care of computing resources by not consuming a lot of resources in the parent partition or hypervisor through emulation.

Virtual machine generation determines its' virtual hardware and functionality. The VM created with generation 1 supports legacy drivers and user Basic Input/Output System (BIOS) based firmware/architecture. It relies on the emulated IDE (Integrated Development Environment) controller for boot capabilities. Thus, it is also called "legacy virtual machine". It only initializes the IDE controller for OS to initialize a file system as in Figure 2. (Sharma, 2013).

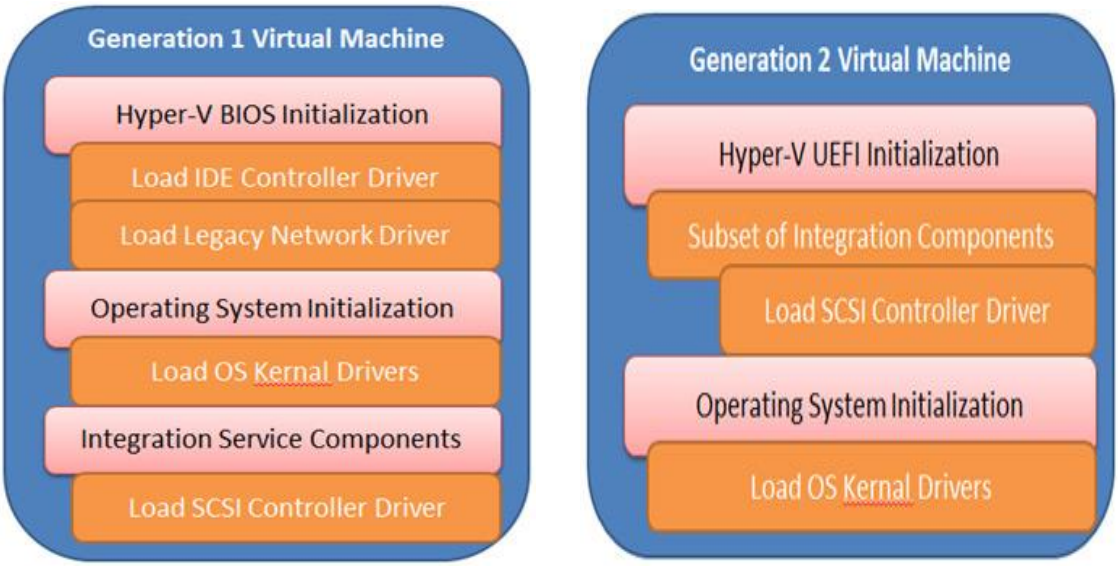


Figure 2. Initialization of generation 1 and generation 2 VM (Sharma, 2013)

Generation 2 VM does not require a majority of emulated / legacy devices during initialization that requires for generation 1 VM. Thus, it is free of legacy hardware. All devices run as synthetic VM Bus hardware. It has simplified virtual hardware model and supports UEFI (Unified Extensible Firmware Interface)-based firmware/architecture. It comprises a subset of integration services that allow the SCSI controller to initialize before the OS starts loading as in Figure 2 (Sharma, 2013).

Generation 2 VM has many new features such as secure boot (enabled by default), boot from a SCSI virtual hard drive/DVD drive, PXE (Preboot Execution Environment) boot using a standard network adapter, and of course UEFI firmware support. It also supports IPv6 network installation.

Although both VM generation support DVD, there is a difference in the ways of supporting. For instance, a DVD device is always attached to the IDE controller by default in generation 1 but such default is not present in the later generation. Similarly, the DVD device cannot be removed (but media can be removed from the device) while the VM is powered on. On the other hand, generation 2 comes with a hot-added feature which means DVD can be removed during running of VM. Nevertheless, the former one can support only 4 DVD devices but the latter can support 256.

Furthermore, the physical drive pass-through is supported by generation 1 only. One more interesting fact is that both generations support a SCSI controller but still a SCSI DVD cannot be used on a generation 1 (Howard, 2013).

The boot volume of generation 1 VM is 2 Terabyte (TB) while the generation 2 is 64 TB. 64 TB is also the maximum size that can support by Virtual hard Disk (VHDX) (Howard, 2013). The performance of generation 1 VM is not significantly different from that of generation 2 VM in its daily running. But, the former one is about 20% faster in booting and 50% faster in OS installation.

3 TESTING ENVIRONMENT AND ITS REQUIREMENTS

Before doing any test, it should be ensured that the testing environement meets the necessary requirements. The test will comprise of two components, that is, a test Server and a test Client. A PC installed with the Datacenter edition of WS2012 R2 acts as a test Server while another PCs (running with Windows 7/8.1) and two smartphones (an android and an iPhone) as test Clients. Test PC client and test Server are supposed to be a domain-joined in the same workgroup.

In addition, the tester is supposed to have some IT knowledge, such as creating, formatting and removing partitions on a hard disk drive, settings power management options, installing and configuring network, installing the operating systems in PC, downloading a service parck for an operating system, installing the Active Directory Domain Service Role with subroles and options.

Similarly, PCs for both server and client; and smartphones, where tests are going to be performed have software and hardware configuration as in Table 2.

Table 2. Hardware configuration of test machines

Machine	Processor	RAM	Harddisk	Opearting System
Server (in real) Server (in virtual)	2.9 GHz i5 64-bit (in real) 2 core (in vitual)	8 GB 4 GB	500 GB 127 GB	Windows Server 2012 R2 Windows Server 2012 R2 (Datacenter Edition in both)
PC Clients	2.9 GHz 32-bit	4 GB	250 GB	Windows 7/ 8.1
Smartphone	- -	- -	64 GB 32 GB	KitKat 4.4.4 (Android) IOS 8.0.1 (iPhone)

3.1 Testing aspects

Software testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test (Kaner, 2006). It encompasses a wide range of procedures or activities in order to check their

reliableness. Generally, the testing process for any software having graphical interface has three diffrerent aspects, namely, functional, performance and usability testing.

Functional testing (also known as specification-based testing) is a process where the software is tested without the tester knowing the internal structure of code. Hence, it is also known as black box testing (Software Testing Class, 2012). It is the most fundamental part of testing as it shows whether an application works as specified by design. For this thesis, the test will be carried out to determine the software and its requirements by analyzing responses during inputs of both valid and invalid norms.

Perfomance testing is non-fuctional testing where a test is carried out in order to verify the ability of a system to handle varying degrees of concurrent users and system transcations. It is also known as stress testing or load testing or volume testing. In this test, user and system response times are measured and referenced against the non-functional requirements. The test shows the performance and effectiveness of the software along with its features.

Usability testing is carried out from an end user’s perspective to determine if the software is easily usable or not (Seela, n.d.). So, the test will be focoused on the easiness of learning, using and familiarizing with prospective software and its features. Moreover, end users will be also part of the test.

4 TESTING IMPLEMENTATION AND RESULTS

4.1 Requirements of Work Folders and its working mechanism

In order to install Work Folders, the server must have the WS2012 R2 version operating system. In addition, the hard drive should be in the New Technology File System (NTFS) file system in order to store user files. Similarly, Windows 8.1 / Winrdows RT 8.1 / Windows 7, as an operating system, should be installed in Client computers. Smartphones and tablets must be running on Apple IOS 8.0.1/Android 4.0+ for installing Work Folders. Beside these, there should be enough space in the hard drive of server in order to store work files in Work Folders, for all users (Microsoft Library, 2013).

The working mechanism of Work Folders seems almost as same as other online storages but the main difference is that Work Folders are manageable. During use of Work Folders, the corporate administrator can manage stored data along with users' connection to Work Folders. The administrator can also use the encryption function to Work Folders in order to maintain security in a situation, where users are not a domain member.

Another characteristic of this feature is that users can work with Work Folders from both domain-joined and non-domain-joined devices while they are in local network or out of network (For example, while at home or travelling). Previous versions of Windows Server are capable of connecting only domain-joined devices when they are located inside corporate network. On the contrary, the newest version can do both domain-joined and non-domain-joined devices, located both inside and outside corporate network (home, travel).

The task is accomplished with the help of the Device Registration Service (DRS) feature, which enables connection of non-domain-joined devices, too. It is one of the sub roles of Active Directory Federation (ADFS) roles. During the connection process, DRS creates a device object in AD and tracks the certificate of the respective device in order to represent the device's identity.

After tracking the device's identity, DRS registers the device into domain (not joins into domain) and begins the connection.

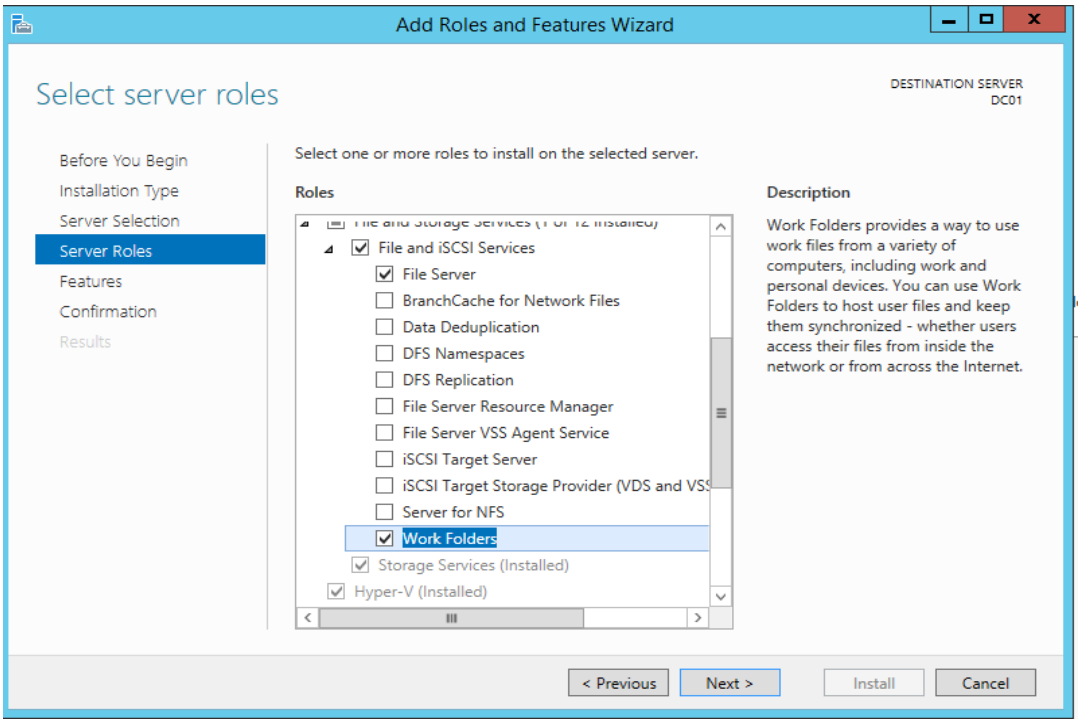
According to Abluton (2014), a new role service called Web Application Proxy (WPA) plays a key role during the connection of devices outside of network or access of the corporate server remotely (i.e. non-domain-joined devices). It will work as both a reverse proxy for publishing applications to external users and also as the ADFS proxy. Figure 3 (Microsoft Library, 2014) shows the working way of Work Folders.

Figure 3. Working mechanism of Work Folders (Microsoft Library, 2014)

Once the device is connected, it becomes "Known device" and it will provide seamless second factor authentication and Single-Sign-On (SSO) to access work data and resources from corporate server. Although there is a SSO system, an administrator can control corporate data on centrally managed file servers and can also specify user device polices such as encryption and lock screen passwords.

4.2 Configuration and testing of Work Folders

Both Graphical User Interface (GUI) and PowerShell (PS) commands are available in order to install Work Folders in a server. In our testing server, the Work Folders was installed using GUI. The installation was started with clicking “Add Roles and Features” of Server Manager which resulted into a Wizard. The Wizard had an option to check/uncheck Work Folders for installation as in Picture 2.

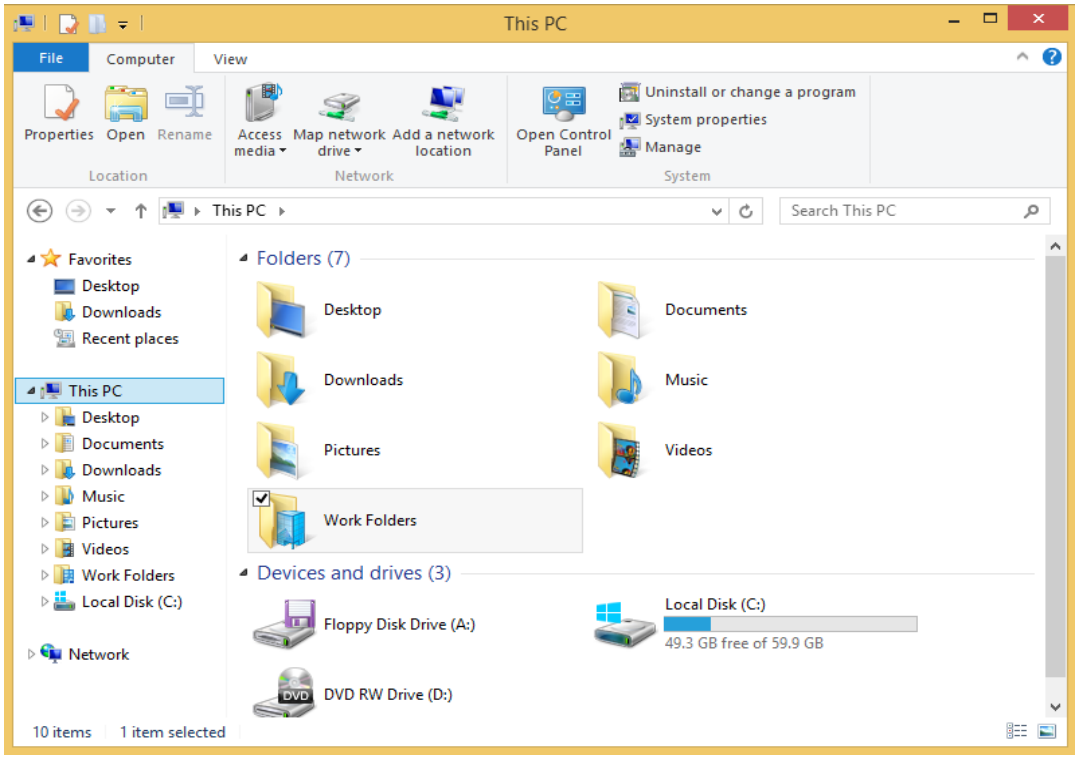


Picture 2. Selecting Work Folders option in Add Roles and Features Wizard

The installation needed another .NET framework 4.5 feature to be installed before it started. After the completion of the installation, the running of another Wizard was needed in order to create a Sync Share for Work Folders. It also involved choosing a path for Work Folders, adding of users and managing group policies and updating them.

The client PC had Windows 8.1 as an operating system and was joined to a domain. In addition, the Work Folders was browsed through Control Panel and

its setup started with a Wizard. The completion of Wizard resulted in a folder named “Work Folders” in Windows as in Picture 3. Thus configured Work Folders was possible to be accessed by a client only after updating policies in the server and restarting of the client PC. Furthermore, the synchronization between Work Folders of a server and clients also took place without any error.



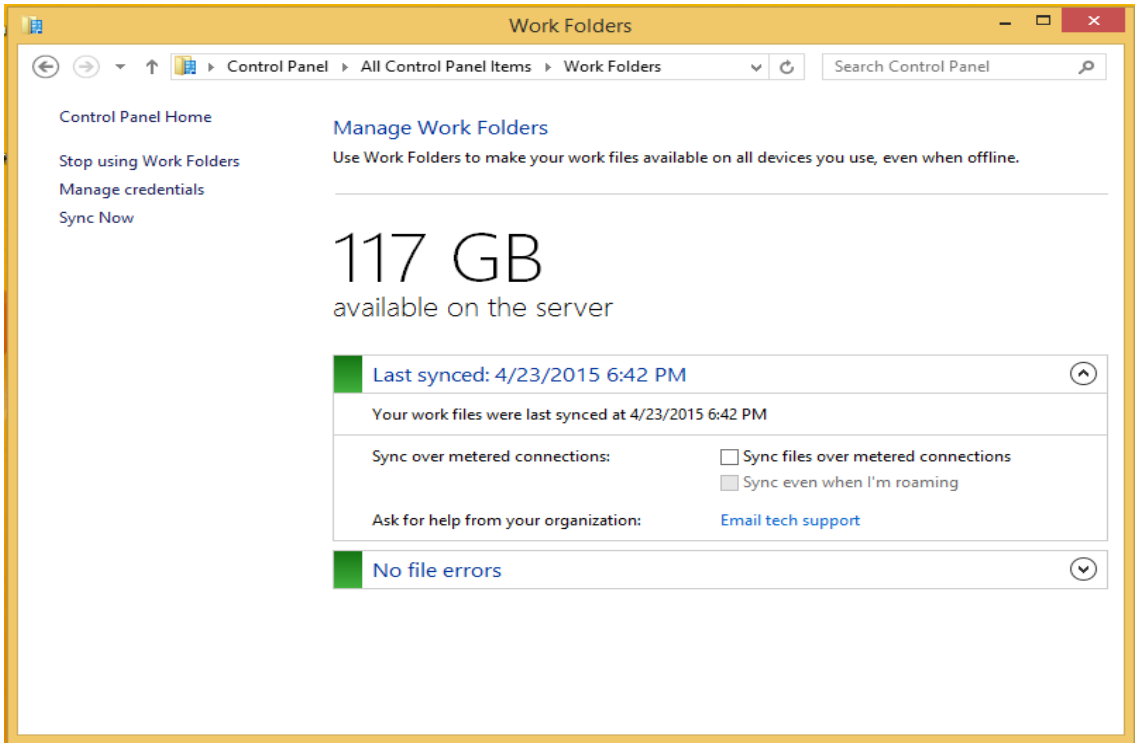
Picture 3. Client Windows showing Work Folders

Clients having Windows 7 operating system could not work with Work Folders, unless a software package to support Work Folders was installed. The package was available at Microsoft website free of cost. In the iPhone, the configuration was succeeded. However, in the Android smartphone, it was not possible to configure the Work Folders as the application realted to Work Folders was not available in Google Play (a source of android application).

The test also showed that the Work Folders server must joined into domain in order to maintain a connection for intranet and internet. After joining into the domain, Work Folders could become a single point of access for work files from both user’s work and personal devices.

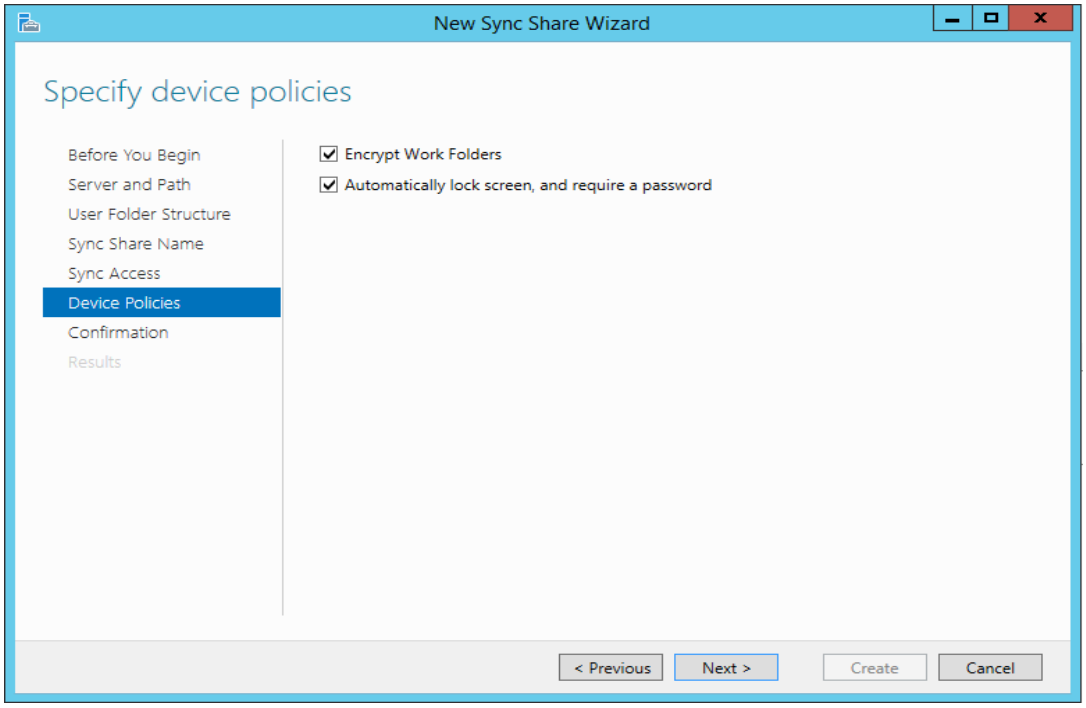
During testing, the server was turned off unexpectedly for five minutes, in order to create a catastrophic failure like situation, such as electricity failure. However, such failure did not affect the synchronization of files. Even after the server ad been down, it was still possible to access offline files and work on them. After restarting of the server, the work files within Work Folders became synchronized as soon as it connected to internet and intranet.

It was also possible to know different parameters of the synchronization of folder within Work Folders. For instance, synchronization status, last synced time, space available in hard drive of server and options for metered connection synchronization (Picture 4).



Picture 4. Parameters of synchronization

Enabling the settings for personal devices (as in Picture 5) was also possible. The text colour of non-encrypted Work Folder was black but when it was encypted later, it changed into green.



Picture 5. Enabling settings for Personal devices

Organizations utilizing the Work Folders in their working environments can bring many benefits for the users of the environments, as well as, for themselves. There are some advantages and disadvantages of Work Folders, such as:

Advantages

- Access point and multiple location of folders

  It provides a single point of access to work files from any personal devices, whenever and wherever they want. So, Work Folders can act and exist in multiple locations. Thus, there will be no need of staying inside the corporate network for company work.

- Easy to connect and reliable

  It makes it easy to connect users' devices with corporate servers and also helps to access corporat data easily, whenever the internet or intranet is available.Thus, the feature is very reliable.

- Single-Sign-On (SSO)

  This feature requires just one time sign in, hence called “Single Sign-On” system, in personal devices in order to get access to corporate servers. After first sign in, there would be no need to enter their credentials again. Users gave no restriction to use corporate data and resources.

- Secure

  The connection between the users’ personal devices and the corporate server is always authenticated, hence, it is always secured. Ultimately, secure connection provides maximum security to corporate data and reduces information leakage. In addition, the enforcing of server policies in client devices enable data to be controlled by the corporation.

- Publish Work Folders to internet

  With the help of Work Folders, users can publish it to the internet using the web application proxy functionality (available on WS2012 R2 only), enabling synchronization of their data, whenever they are connected to the Internet. In order to publish Work Folders, users can use Microsoft’s publishing mechanism such as Microsoft Forefront's Unified Access Gateway (UAG).

Disadvantages

- Work Folders can be installed only in WS2012 R2. So, any architecture that does not support WS2012 R2, is unable to work with Work Folders. Similarly, organization using older version of Windows Server won’t be able to use this new feature.

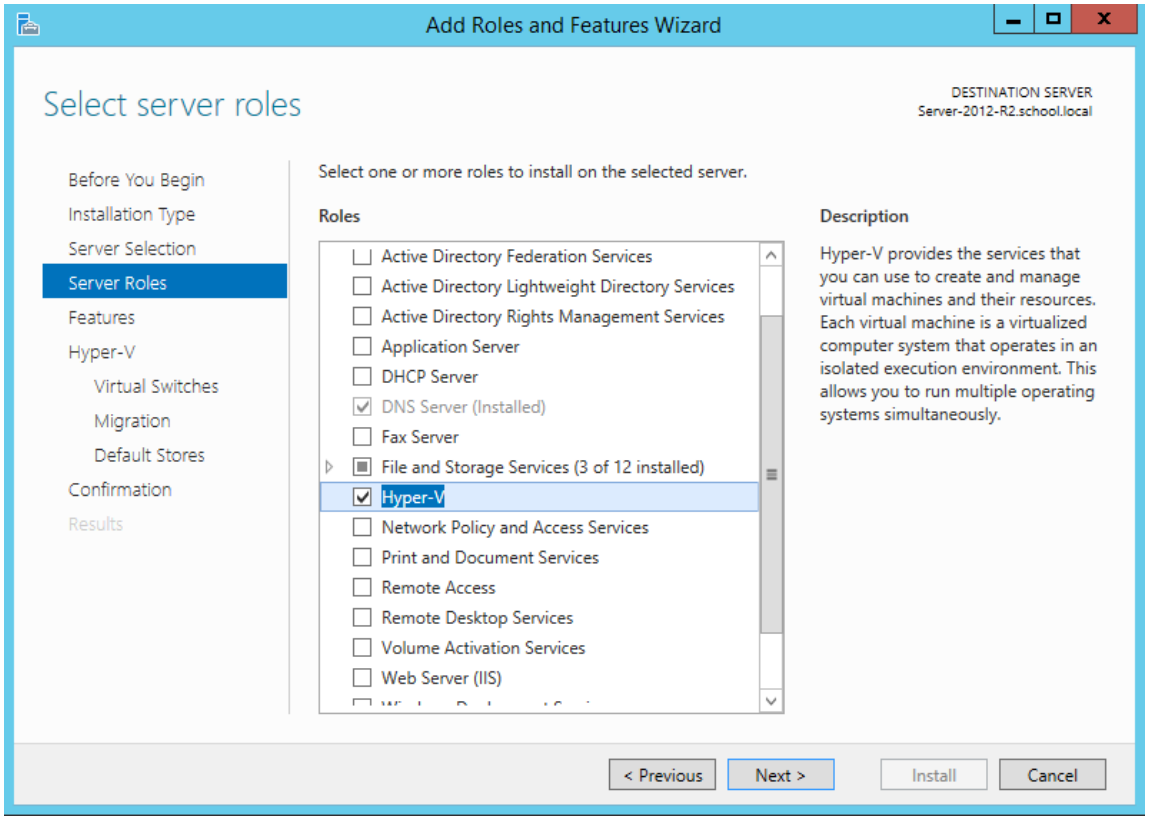
- Work Folders is also not supported by any architecture having UNIX operating system.

4.3 Requirements and configuration of Hyper-V

Basically, Hyper-V needs a 1.3 GHz 64 bit processor as a minimum hardware requirement for installation. In addition, the processor should include hardware-assisted virtualization and hardware-enforced Data Execution Prevention (DEP) enable, 1 GB RAM and 32 GB hard drive and a NIC (Microsoft Library, 2010).

Hyper-V can be installed in any Windows server version later than Windows Server 2003. However, in order to install newest roles and features of Hyper-V, the requirement is as same as that of WS2012 R2 (Table 1).

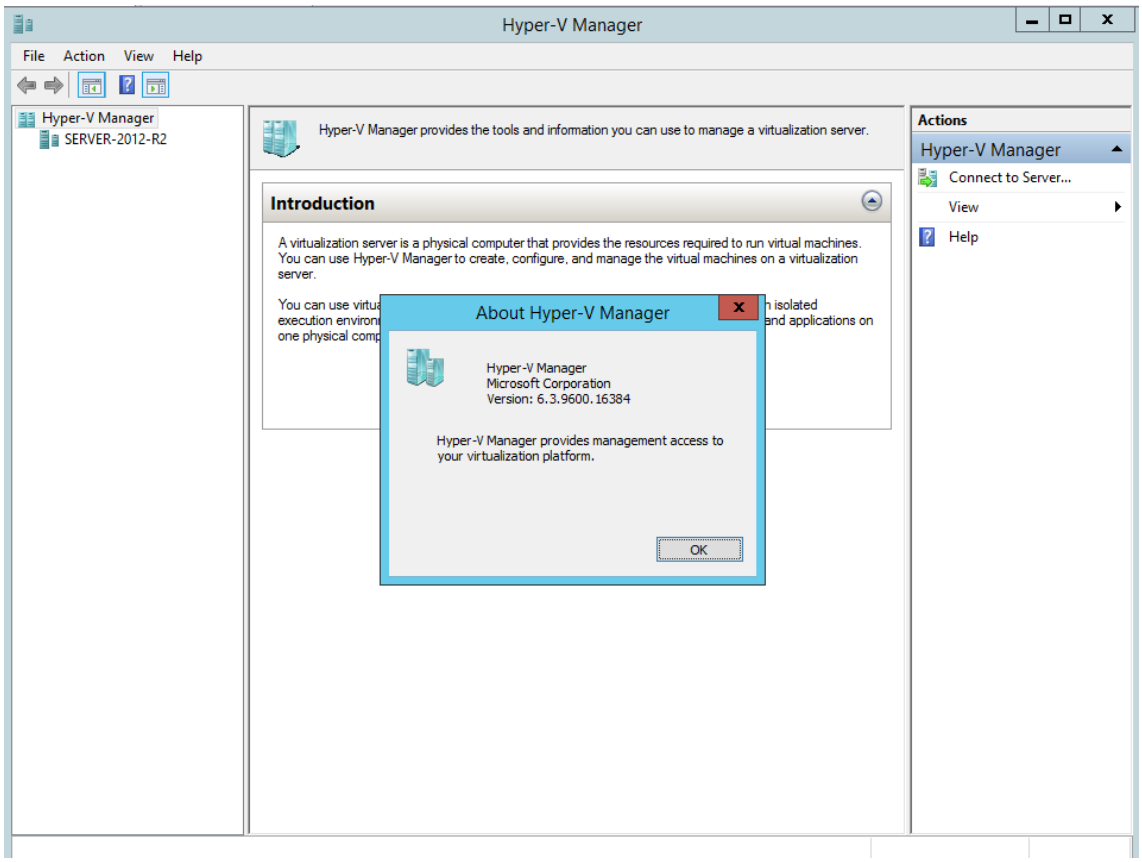
The installation of Hyper-V can be done through both Server Manager and PowerShell. In the real testing server, it was done through Server Manager. The “Add Roles and Features Wizard” provided an option to check and install the Hyper-V role (Picture 6). It also invovled the creation of virtual switches.



Picture 6. Selecting of Hyper-V option during installation

However, in VMs, installation of Hyper-V was not as easy as compared to the real machine. The initial installation failed with showing then error “Hyper-V cannot be installed: A hypervisor is already running”. This was corrected by enabling “enable hypervisor applications in the virtual machine” option of VMware workstation.

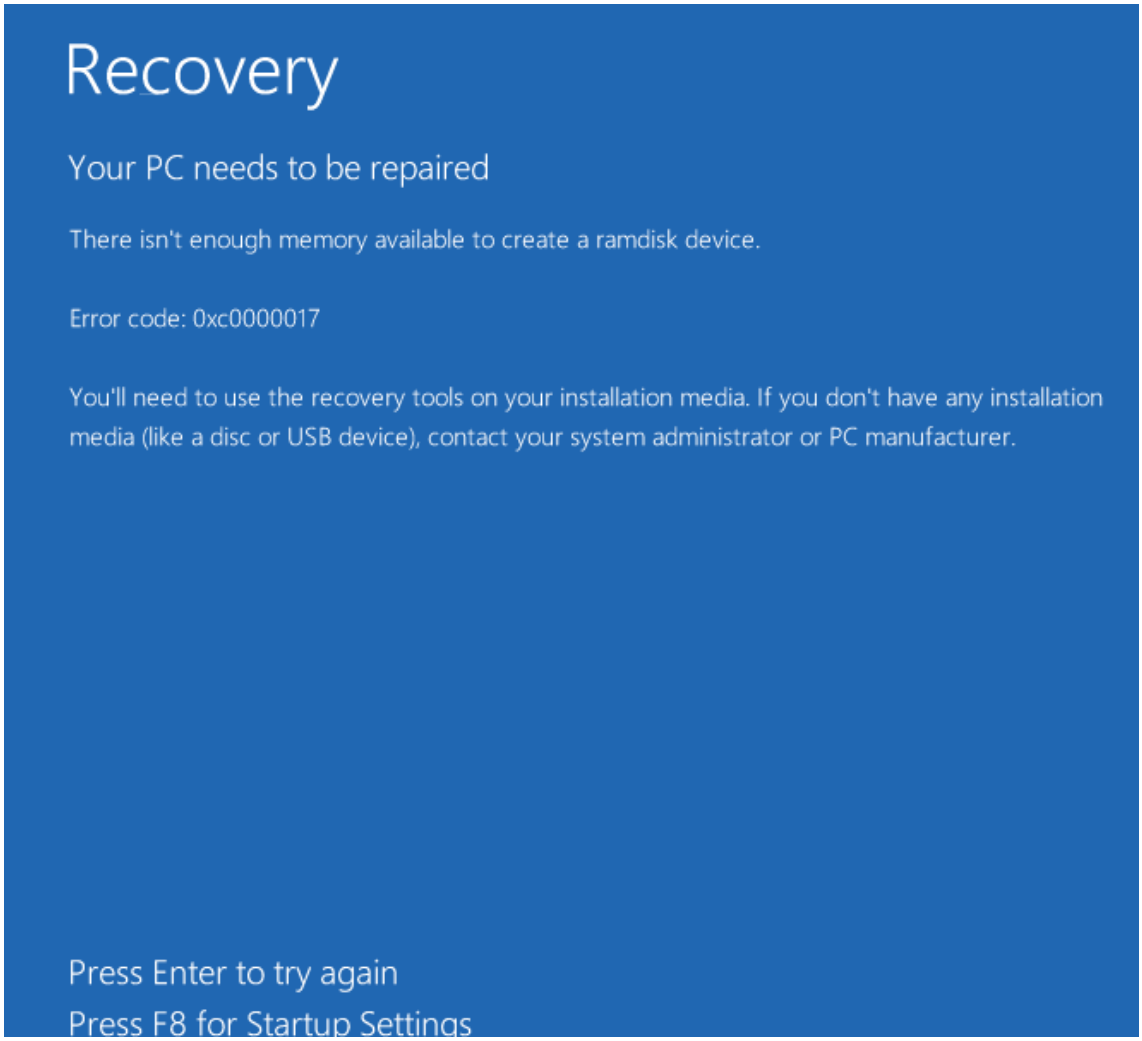
The server was restarted after completion of all necessary steps. After booting, the Hyper-V was ready for any action. The newest version of Hyper-V is 6.3 (Picture 7).



Picture 7. Screenshot of Hyper-V Manager 6.3

After launching Hyper-V, one generation 1 VM having Windows 7 OS and the other generation 2 VM with Windows 8.1 were created. During creation of VMs inside Hyper-V, support of Random Access Memory (RAM) was tested. When there was a RAM less than the requirement, the installation could not start and

showed a message as in Picture 8. So, they were created only after providing the recommended RAM size (more than 1 GB).



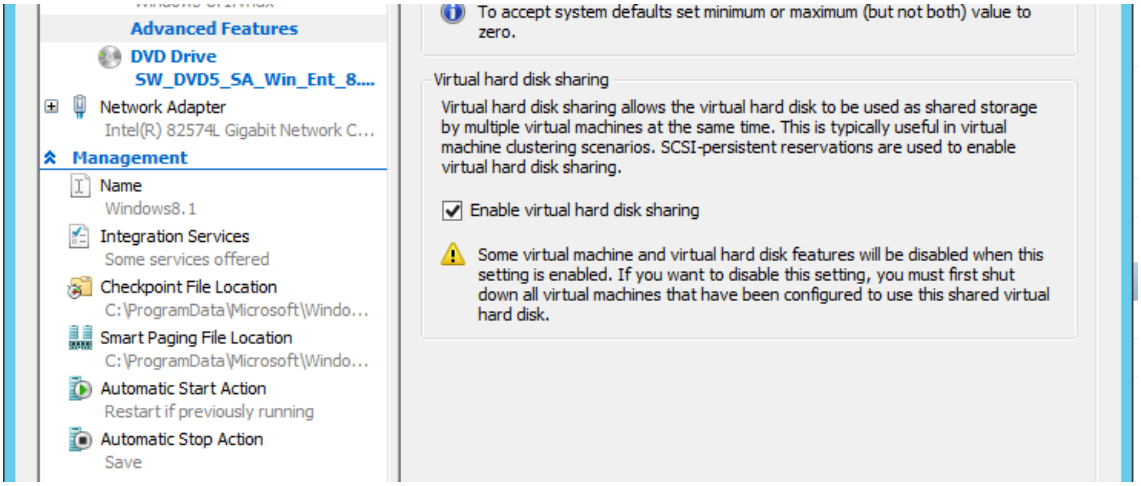
Picture 8. Memory error during installation of VMs

4.4 Hyper-V's new features and their testing

Numerous new features are associated with the newest version of Windows Server. However, the tests were carried out with only the following features:

Shared virtual hard disk

One of the newest feature of WS2012 R2 is enabling virtual hard disk sharing as in Picture 9. Actually, it is, as name suggests, a sharing of virtual hard disk file (VHDX) in order to create and manage a guest failover cluster (also known as VM failover cluster) for the protection of the application services running inside VMs. A shared virtual hard disk allows two or more VMs to access same virtual hard disk file.



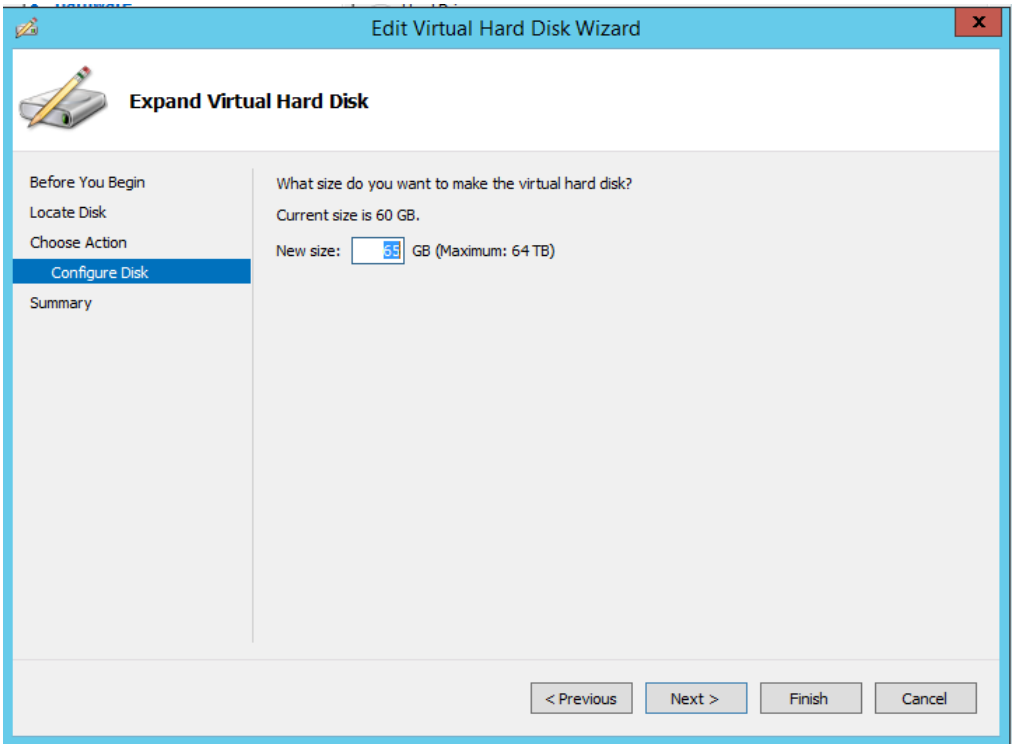
Picture 9. Enabling virtual hard disk sharing in Hyper-V

In the previous versions of the Windows server, the storage topology should be exposed to VMs to share VHDX but in the newest version, the failover cluster is not bound to storage technology. Sharing a VHDX file provides the storage space needed for the Hyper-V guest failover cluster.

Resize virtual hard disk

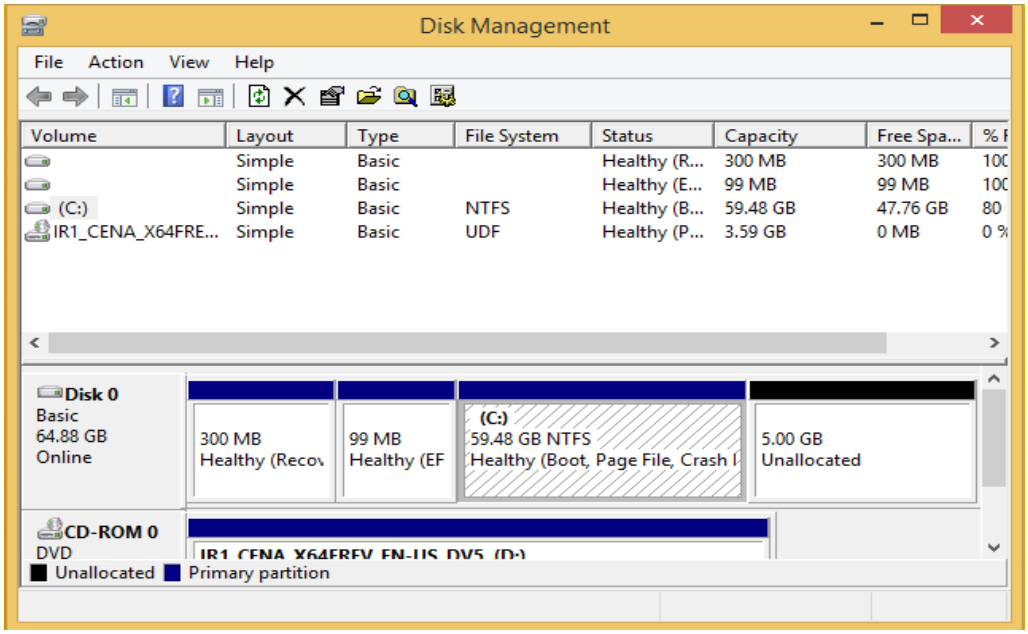
The newest version of Windows server provides an option to resize the running virtual hard disk, if it is attached to the SCSI controller. It enables an administrator to perform configuration and maintenance operations on virtual hard disk while the associated VM is online or the virtual hard disk data disk is in use or VM is still running on the host. The disk capacity of virtual hard disk increases when the virtual hard disk expands and it decreases on shrinking the virtual hard disk. However, there is a general limitation on the shrinking capacity of the virtual hard disk below the size of the currently used volume within the VM.

The online resizing of virtual hard disk can be operated through both “Edit Virtual Hard Disk Wizard” and Windows PowerShell interface options. However, in testing, it was done through the first one only. The capacity virtual disk was expanded from 60 GB to 65 GB (in Picture 10) and again shrunk from 65 GB to 65 GB (in Picture 12).



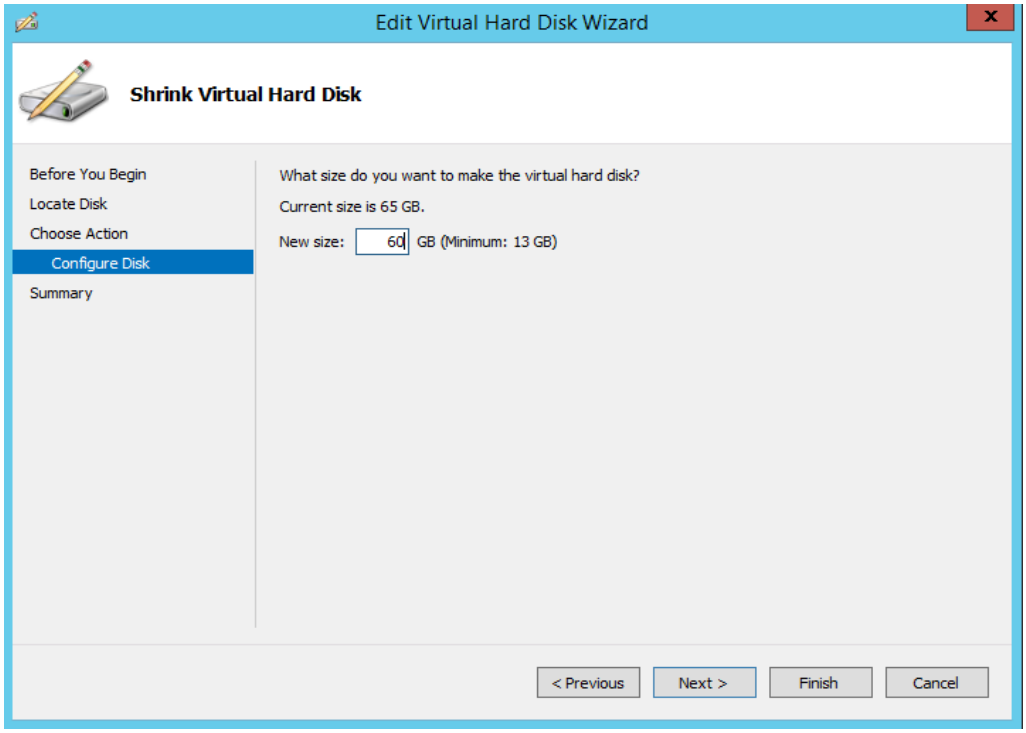
Picture 10. Expanding virtual hard disk from 60 GB to 65 GB

Initially, the expanded hard disk was an allocated space and it needed to extend by extending option of Disk Management, which completed the expansion process and showed the expanded size (Picture 11).



Picture 11. Disk Management showing expanded 65 GB virtual hard disk

The shrinking process was just reverse of expanding. It was started from Disk Manager and ended with “Edit Virtual Hard Disk Wizard” (Picture 12).



Picture 12. Shrinking virtual hard disk from 65 GB to 60 GB

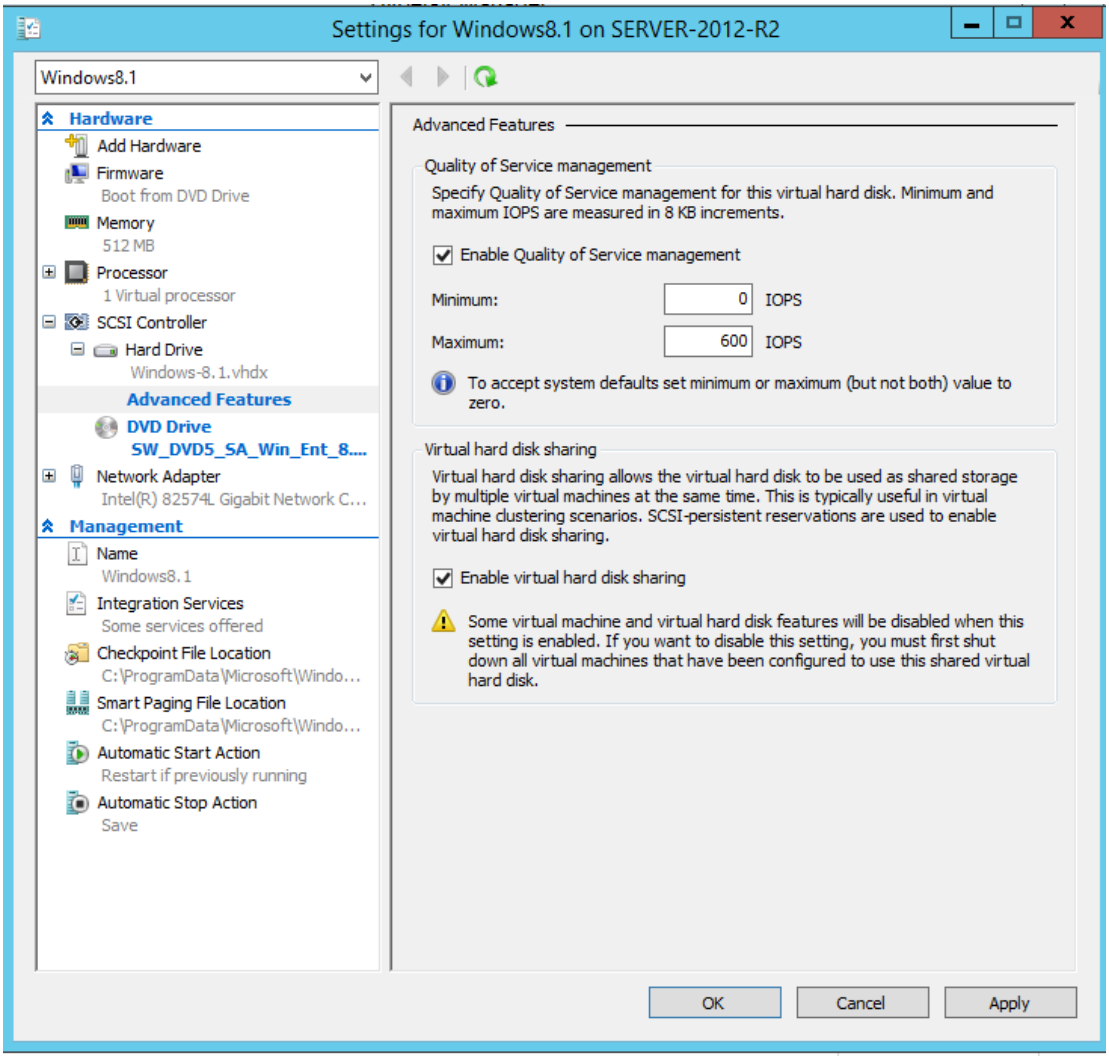
The test also showed that, there was not any interruption in any programs or accessing the workloads in VM while its virtual hard disk was resizing. It went as smooth as Microsoft describes.

Storage Quality of Service (QoS)

The new file-based feature is important especially in multi-tenant infrastructures. It provides an ability to specify a maximum and minimum input/output operations per second (IOPS) value for virtual hard disk on a Hyper-V host. It also helps in storage performance isolation in a multi-tenant environment and mechanisms to notify when the storage I/O performance does not meet the defined threshold to run VM workloads efficiently.

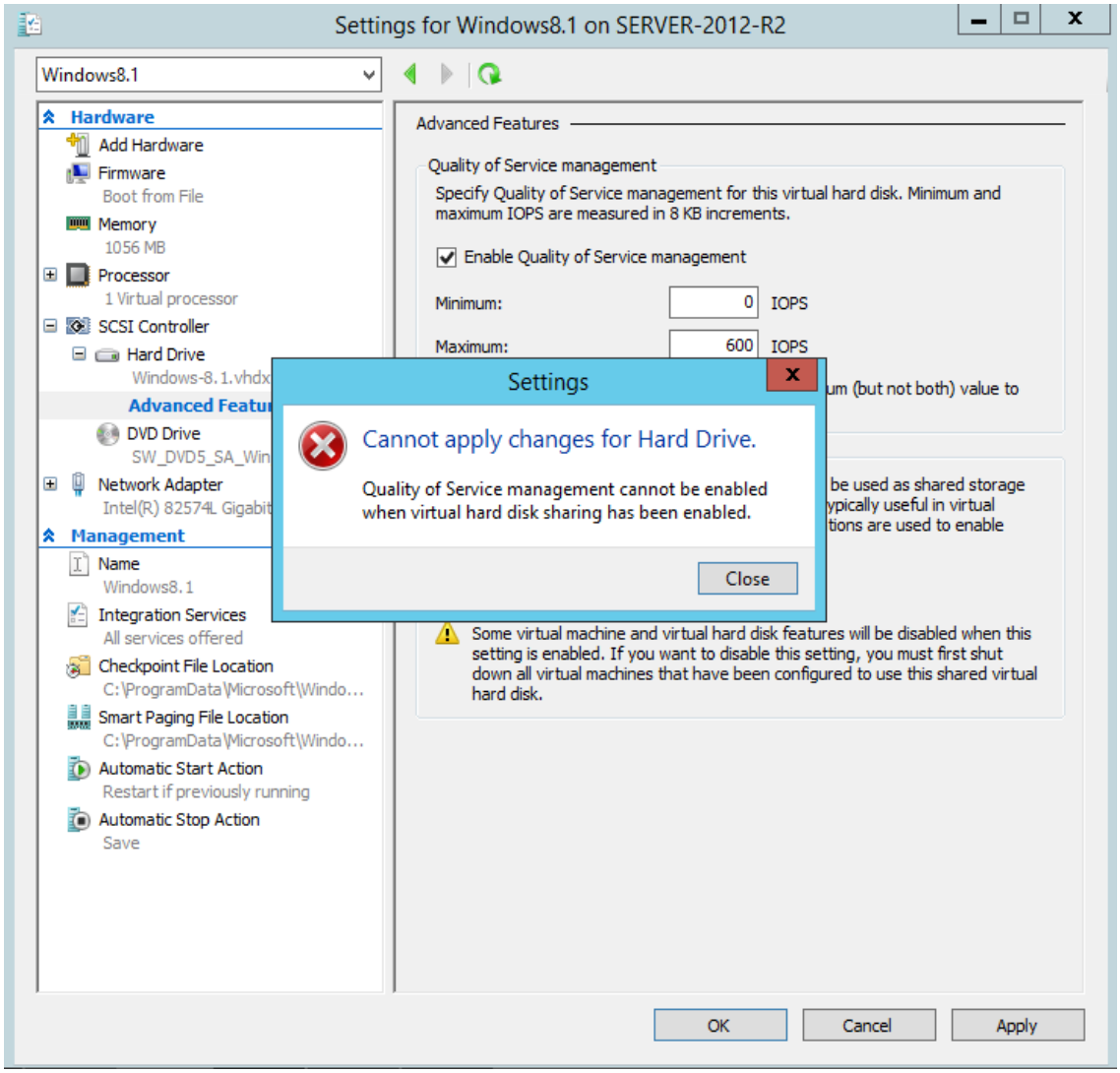
In test, settings for minimum and maximum IOPS were configured 0 and 600 respectively (Picture 13) and activated. These IOPS were measured in 8 KB

increments. During testing, both VMs ran smoothly and there was not any notice of not meeting the defined threshold.



Picture 13. Configuring Storage QoS for a VM

The test showed an error during enabling of QoS management while enabling of sharing hard disk was on (Picture 14). It could be applied only, after disabling of virtual hard disk sharing. The settings accepted only either sharing of virtual hard disk or QoS.



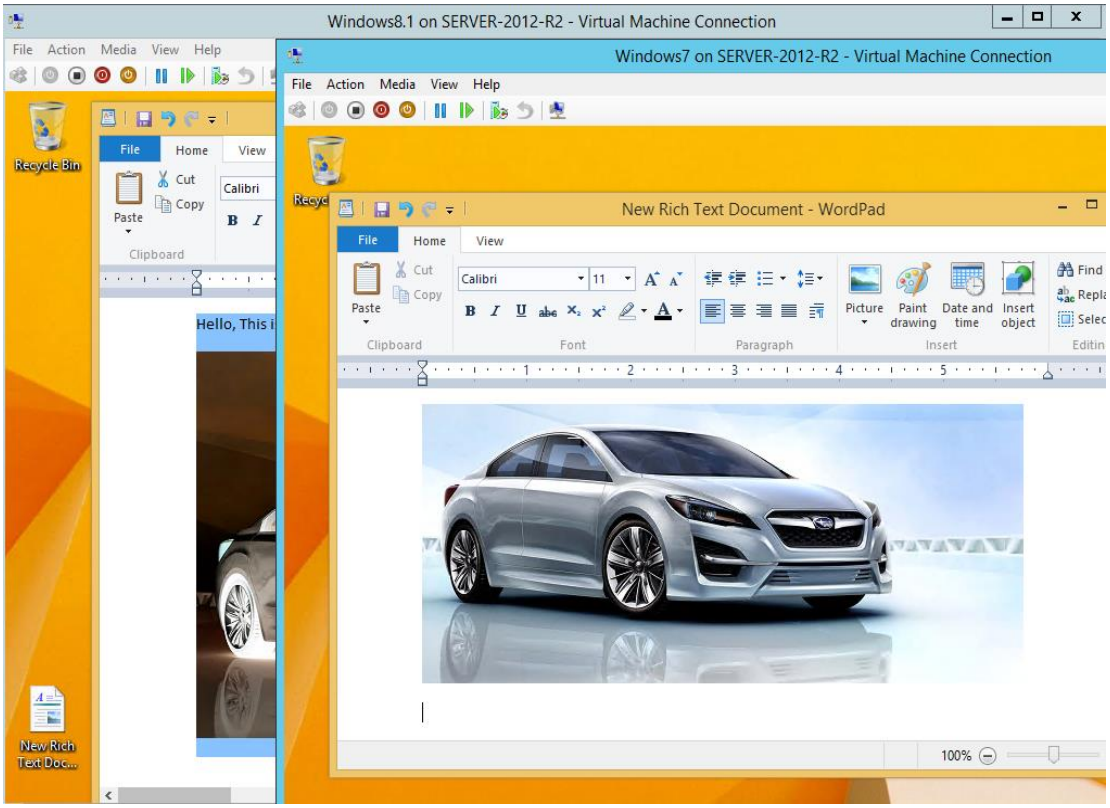
Picture 14. Error during enabling of QoS and Sharing of virtual hard disk

Enhanced session mode

It is a process of redirection of certain local resources to VM session through VM tool. It gives an administrator more functionality when connecting to VM through Remote Desktop Connection. The local resources those redirect are Display configuration, Audio, Printers, Clipboard, Smart cards, USB devices, Drives, Supported Plug and Play (PnP) devices.

It uses RemoteFX Protocol (initially called Remote Desktop Protocol) and provides almost similar type of resources direction to VM as in Remote Desktop Session (Finn, 2014).

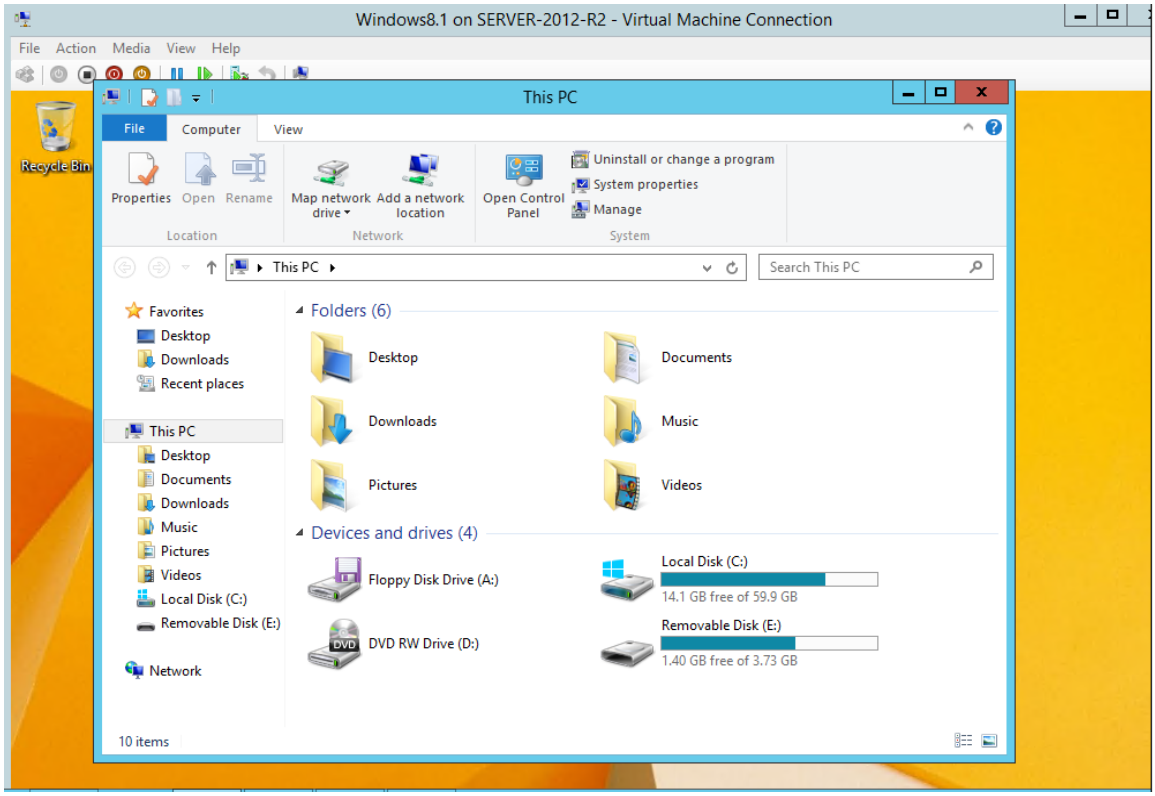
In the test, it was found that enhanced session mode was disabled by default in Hyper-V in server but enabled by default in client Hyper-V. After enabling the enhanced session mode, the copy-paste (even the rich text) between host server and VM was successful even without any network connection as in Picture 15. The process was succeessful for both generations of VM. It was also possible to copy-paste between two different generations of VMs. Furthermore, the copy/paste was as simple as within any physical host.



Picture 15. Rich copy-paste between server and VM

The test also showed options to use remote audio, printers and clipboard as local resources. The options also included the settings for resolution of VMs. Picture 16 showed the successful conncetion of usb device by a VM running

Windows 8.1 operating system. Here, the usb device was actually attached to a host server but was used by a VM.



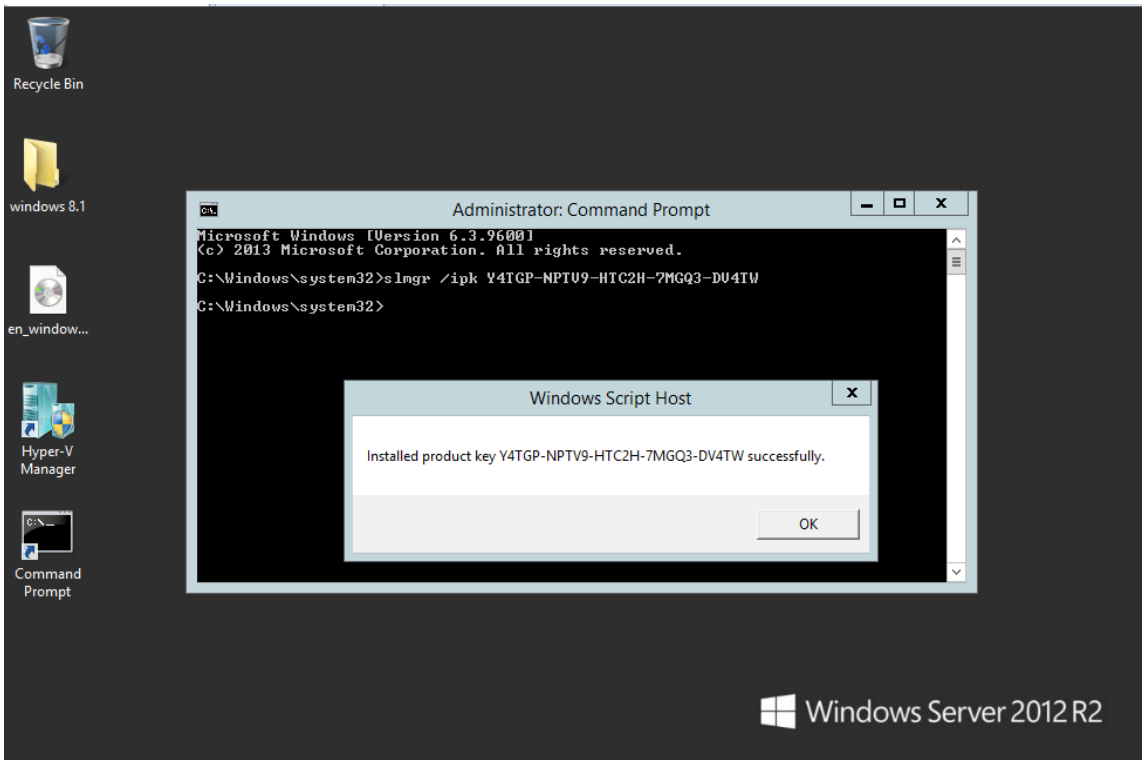
Picture 16. VM showing USB device attached to the server

Automatic Virtual Machine Activation (AVMA)

WS2012 R2 has “Automatic Virtual Machine Activation” in its’ Datacenter edition that activates a VM running with any version of WS2012 R2, automatically without using any external licensing process and network connection, as long as the host is activated.

To test this feature, the Datacenter edition of WS2012 R2 was installed and activated. The sources of the product key used for activation were both genuine and fake (tested separately). Furthermore, four different versions of WS2012 R2 were installed in VMs. The Microsoft given product key was installed in the host server (Picture 17 shows key installation for the Datacenter edition). The installation automatically activated the respective version of WS2012 R2.

Moreover, the given keys were tested to activate VMs running Windows 7 and Windows 8.1. However, the installation did not succeed and showed an error.



Picture 17. Installing product key for AVMA

After activation through AVMA, VMs worked as well as the physical host which was activated by its genuine product key. The test showed that moving or copying of thus activated VM via AVMA also worked well in another environment. In the new environment, it was still in activated state. In addition, all applications ran well even after moving and copying.

The use of server virtualization showed a number of advantages, from cost to performance. Here are some of the advantages and disadvantages listed.

Advantages

- The primary benefit of using server virtualization is the reduction of costs of operating and maintaining physical servers by increasing hardware

utilization. Thus, it saves money in terms of purchasing physical hardware, operating system licensing costs and power and cooling physical servers.

- The amount of hardware needed to run server workloads is reduced. In addition, it increases development and test efficiency by reducing the amount of time it takes to set up hardware and software and reproduce test environments.

- Server availability is improved without using as many physical computers as the user would need in a failover configuration which uses only physical computers.

- It provides flexible environment to perform various tests as it has ability to speed up setting test environments and restore to earlier points of return tests.

Disadvantages

- Hyper-V is the key of virtualization world in server and whole server system always depends upon it. Thus, any kind of Hyper-V failure results shutdown of whole system, which might leads to loss of important data. Furthermore, it increases the complexity in the system as whole system is based on a single Hyper-V.

- It works only on those architectures which meet the minimum requirement as in Table 1. So, it does not fit for all hardware systems.

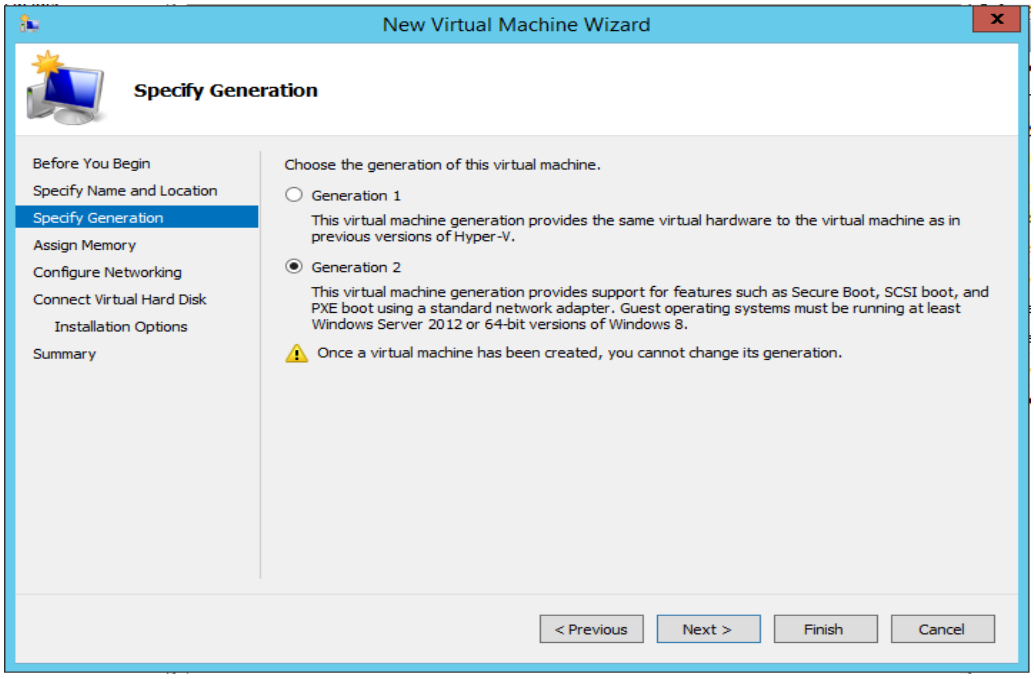
- It mostly needs (in some, OS has in-built package) a software package called “Integration Services” in order to improve integration between physical host and VM. Thus, the user might need to pay for the software which increases the server setup cost.

4.5 Requirements and configuration of Generation 2 Virtual Machine

Generation 2 VM can run only in architecture having WS2012 R2 operating system. Furthermore, there should be enable of Hyper-V role on hosts. In any operating system other than WS2012 R2, the VM manager avoids placing generation 2 VM on hosts (Microsoft Library, 2013). The VM uses a virtual hard disk in .VHDX format.

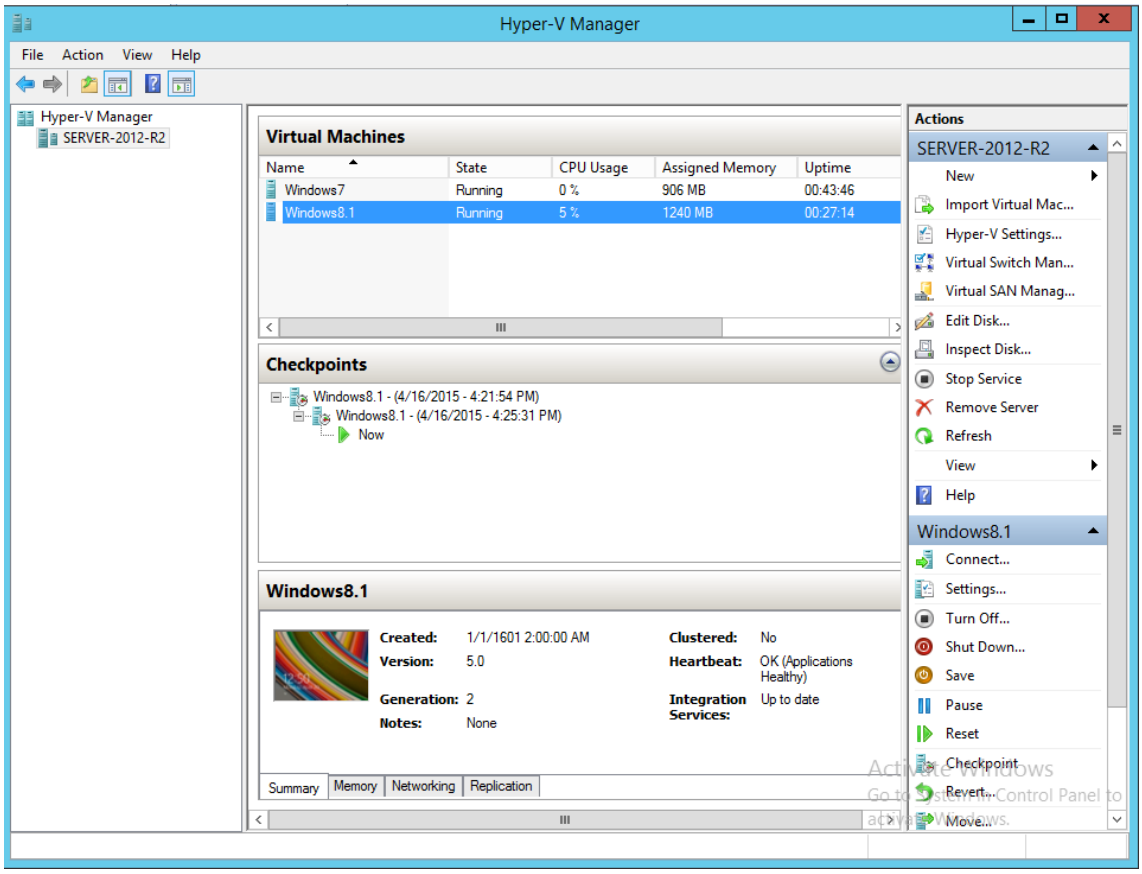
The machine currently supports only four Windows operating systems as guest operating system namely, Windows Server 2012 R2, Windows Server 2012, Windows 8.1 (64-bit) and Windows 8 (64 bit) (Microsoft Library, 2013) and Ubutnu 14.04 (64 bit) as UNIX operating system (Savill, 2014).

The WS2012 R2 has a characteristic feature to create both generations of VM,i.e., generation 1 and generation 2. Both generations of VM could be created under the Hyper-V manager. The configuration process was easy. VM was configured through “New Virtual Machine Wizard” by right clicking a Hyper-V node. The Wizard allowed to specify name, location and of course the generation of VM along with other configuration such as memory assigning and network configuration. However, the default generation was 1. A screenshot showing options is illustrated in Picture 18.



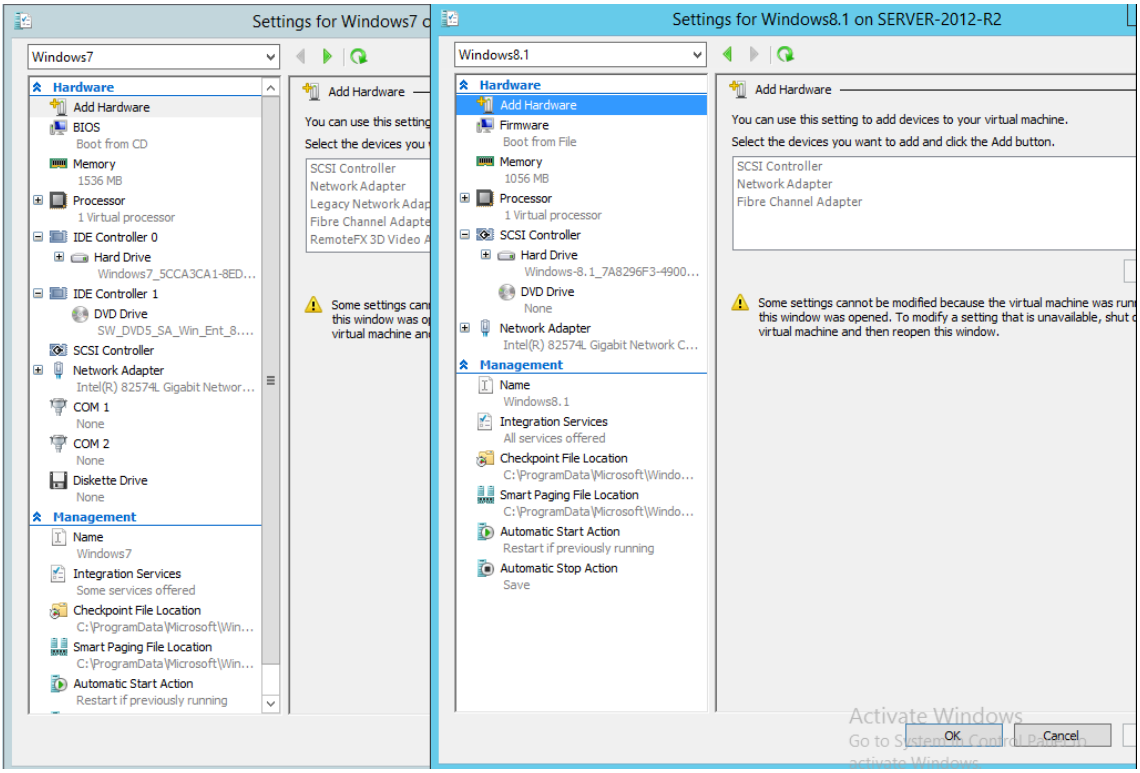
Picture 18. VM generation options with other configuring options

The test showed that the Hyper-V manager can have a number of different generations' VM and it is also possible to run both generation of VM side by side. During test, Hyper-V ran Windows 7 and Windows 8.1 as operating systems. There were no conflicts between these two generations on booting or running. However, after creation of any VM, there were no options to convert one type of generation into another one. A screenshot of testing VMs is in Picture 19.



Picture 19. Hyper-V Manager showing a generation 2 VM

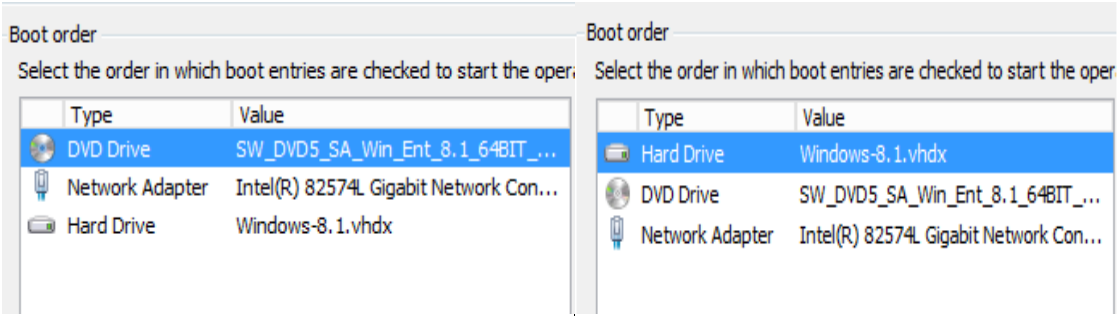
Generation 2 VM used a virtual hard disk in .VHDX format, unlike generation 1 which used in .VHD format. There were more settings/options for generation 1 VM than generation 2 comparatively, as in Picture 20. Especially, legacy drivers, COM ports and diskette drive could not be found in generation 2 VM.



Picture 20. VM settings of generation 1(left) and generation 2 (right)

The boot order in generation 2 VM is much more flexible than the older one as it uses UEFI firmware, not the BIOS. It does not use the traditional boot order. It has a new capability of boot ordering from network using both IPv4 and IPv6. However, this capability is available only in PowerShell and WMI (Windows Management Instrumentation).

The testing VM had a virtual hard drive, a network adaptor and a bootable ISO in a DVD drive for boot. Among them, the DVD drive was the initial boot loader followed by a network adaptor and a virtual hard drive. The boot order was changeable through options. It was possible to keep any of them as an initial boot loader. Picture 21 shows the initial and final boot order (with the virtual hard drive) as an initial boot loader.



Picture 21. Initial (left) and final (right) boot order in a testing VM

The first booting process failed with an error message. Thus, the VM could not be initiated. However, by enabling the SCSI controller in VM settings, so that any primary boot loader will be a SCSI controller, and pressing any key during initiation of booting process, the VM started well. Furthermore, the booting initiating process from an image file (.ISO) attached to CD/DVD drive was also supported.

It was also possible to export VM from one environment to another. After exporting or importing, no error appeared in booting process as well as running application within VMs. Similarly, creating Checkpoints (previously called snapshots) were also possible.

4.6 Characteristics of Generation 2 Virtual Machine

The newest generation of VM removes several old hardware, which are still being emulated in generation 1 VM and stepped it ahead with new features and improvements. Some key characteristics are as follows.

- UEFI based features

  Generation 2 VM comply with UEFI secure boot standard and uses secure boot features of UEFI to initialize rather than the traditional PCAT BIOS used by generation 1 VMs. So, the new generation VM provides a UEFI environment that supports 64-bit operating systems which are

Windows 8 and Windows 2012 or later. Thus, only the newest version of Windows server supports generation 2 VMs.

- Legacy free VM

  A standard set of emulated hardware devices (such as AMI BIOS, Intel 440BX chipset motherboard, S3 Trio graphics display adapter, Intel/DEC 21140 network adapter, keyboard or mouse PS/2 connections, floppy drives, PCI to ISA bridge) are needed to boot from an IDE controller as the assumption was the operating system is not natively virtually aware. However, the newest version is natively virtually aware and does not require such hardware or actually does not support booting. In addition, those devices are replaced with synthetic drivers and software based devices. This makes VM legacy free from old hardware devices.

- SCSI boot

  Previous version of VMs can boot only from IDE disks as their virtual disks are attached to the VM using an IDE controller. However, virtual hard disks of generation 2 VMs which are supported only by WS2012 R2, are attached to SCSI controller. Thus, the newest VMs does not need any IDE controller and can boot directly from SCSI controller (for example, a SCSI virtual DVD).

- Faster deployment

  In comparison, the network based installation of a guest operating system into generation 2 VMs is significantly faster than that of generation 1. There are two reasons for being faster. The first one is that generation 1 VMs generally do not require or support legacy network drivers and install faster. Another reason is the performance of SCSI controller. A SCSI controller performs much better than an IDE controller. As a result, generation 2 VM takes only about half the time as installing the same guest operating system than on generation 1 VMs.

The newest generation of VM has a number of new functionalities that makes it different from old generation. However, some limitations are also present in it. So, most of these new functionalities and limitations are listed here, as advantages and disadvantages.

Advantages

- Booting from a SCSI controller
  Generation 2 VM can boot from SCSI controller (as in Picture 20), unlike generation 1 VM that needs an IDE controller. Furthermore, the relocating of paging file to a SCSI controller is also possible on them. This ability helps in improving the overall performance for applications that frequently require paging operations.

- PXE boot option
  Earlier version of VM requires legacy network adaptor to install an operating system using network boot. However, the newer version can install a guest operating system by connecting to a remote installation service using PXE boot option.

- Security
  Secure booting-which uses a signature checking mechanism during the boot process to validate that only approved components are allowed to run, is enabled by default in generation 2 VM. Thus, this feature helps to prevent unauthorized firmware or UEFI drivers from running at boot time. In addition, unauthorized operating systems, drivers and firmware can be prevented from running when the VM starts. Furthermore, the security attack surface of generation 2 VM is also lower than that of generation 1.
  The options can be modified even after the creation of VM.

- Fast boot time and installation
  The boot time in generation 2 VM is up to 20% faster as it boots from a SCSI controller or standard network adaptor and installation of guest

operating system is almost 50% faster as compared to generation 1 VM. So, it provides faster boot time and installation to users. It makes generation 2 VM useful in such scenarios where new VMs need to be quickly deployed in order to scale out a cloud-based application to meet rapidly increasing demand.

- Native VMBUS (Virtual Machine BUS) support on boot
  Generation 2 VM provides synthetic drivers and devices which enable operating system to use SCSI drivers at boot and does not require any emulated drivers. Yet, generation 1 VM always use IDE drivers to boot unless integration service components have been installed. So, generally, generation 1 VM cannot use native VMBUS on boot but on the other hand, generation 2 VM supports it.

- Fewer devices
  There are fewer devices running in a generation 2 VM compared to a generation 1 VM. This is because generation 2 VM has removed support for all emulated drivers such as an IDE controller and legacy network adaptor. These devices are replaced with synthetic VMBus drivers.

- IPv4 and IPv6 boot
  It supports network boot using both IPv4 and IPv6.

Disadvantages

- Generation 2 VM removes all emulated devices including IDE controller. Thus, any corporation which needs any removed emulated device cannot use generation 2 VM and have to rely on synthetic drivers / adaptors only. Nevertheless, Generation 2 VM supports only 64-bit guest operating systems. Therefore, any architect having a 32-bit system cannot run generation 2 VM.

- Windows operating system prior to Windows and Windows Server 2012 do not support generation 2 VM. So, it causes increases costs in order to replace older version of server and Windows OS.

- The newer generation of VM is not backward compatible. This means that users cannot use exported generation 1 VM with earlier versions of Hyper-V such as Windows Server 2012 and Windows Server 2008.

- Generation 2 VM uses virtual hard drive only in .VHDX format that is incompatible with generation 1 VM which uses .VHD format. Although there is a tool to convert generation 1 VHD data to generation 2 VHDX data, converted data cannot be used for boot initialization process.

- Generation 2 VM implements UEFI-based boot architecture. Thus, non-UEFI operating systems might not work properly in generation 2 VMs.

- Generation 2 VM does not provide any support RemoteFX function. The main reason for not supporting is the dependency of RemoteFX stack in PCI. As PCI is not present in new generation of VM, support for Remote FX is out of question.

5 CONCLUSION AND FUTURE WORK

Microsoft launched its new Windows server packed with more than 300 features and enhancements including Work Folders, Hyper-V products and generation 2 VM. The public perception of Microsoft's big launch was positive. Testing their products is always a worthwhile experience. Thus, Work Folders, Hyper-V products and generation 2 VM were created in a workable testing environment and different functional, performance and usability tests were executed.

The first tested feature was Work Folders which is claimed to be a major upgrade in collaboration among server administrators and users within, and among, organizations. Work Folders has features which facilitate to work through both work and personal devices, online and offline access of shared files among multiple locations, and their synchronizations. These features appear to be well developed, hence, are efficient, secure and reliable.

Hyper-V products are mostly targeted towards server administrators operating different tasks on Windows servers and operating systems. Its features allow administrators to perform previously inapparent technical duties such as support for extensive hardwares and simultaneous running of VMs with various degree of configuration. These options greatly enhance productivity and usability for server administrators, which eases their work and lowers costs for organizations.

On the other hand, generation 2 VM presented a revolutionary step towards VM world. The basic differentiation was that the whole concept of virtualization was broadened with the integration of hardware virtualization, such as secure UEFI boot, SCSI controller, 64 TB capacity virtual hard disk in .VHDX format, sharing of virtual hard disk, QoS, and software virtualization, such as support for different operating systems.

Work Folders could not be tested on Android devices because of the platform's lacking of necessary applications. Therefore, successful configuration and testing on Android devices upon availability of necessary applications is left for the future.

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